Pay. Charles Brown

This aspect of the Fairey Gyrodyne emphasizes the roomy cabin and shows the buffers which protect the tail during landing.

The Gyrodyne

Mechanical Features of the Fairey Helicopter

(Continued from page 79, July 15th.)

LAST week we published the first part of the lecture given by Dr. J. A. J. Bennett to the Helicopter Association of Great Britain on July 10th, in which Dr. Bennett, who is head of the helicopter branch of the Fairey Aviation Co., Ltd., explained the aerodynamics of the gyrodyne principle and pointed out the advantages of the low-torque, non-propulsive rotor. The second part of the lecture, given below, was devoted to a description of the mechanical features which translate theory into practice in the Fairey Gyrodyne.

Automatic Pitch Variation

Apart from the novelty of the gyrodyne configuration, Dr. Bennett said, the Fairey prototype incorporates a number of novel features, with regard to which patents are pending in a number of countries. Blade torsional bearings are eliminated entirely, and collective pitch change is effected automatically about the flapping and drag articulations. There are no flight controls other than stick, throttle and foot pedals. At the request of the Ministry of Supply, however, an alternative hub arrangement has been designed incorporating an over-riding collective-pitch control, mainly for trim purposes at altitude, and this will be evaluated later under a Government contract.

Tilting-head Control

The present machine is controlled by a tilting-head arrangement, which eliminates the multiple levers and bearings of the conventional cyclic-pitch method, although the alternative hub for the Ministry of Supply is provided with cyclic-pitch as well as collective-pitch control. It should be of interest to compare the operation of the two alternative systems on the same aircraft.

Cyclic-pitch control has so far been preferred for helicopters, and control by tilting of the hub axis has been preferred for rotors which are autorotative in flight, mainly for reasons of mechanical simplicity in both cases, but also, in the case of the helicopter, because cyclic-pitch control allows the tip-path plane to remain nearly perpendicular to the hub axis, which is important for the purpose of minimizing vibration.

As the gyrodyne rotor normally operates neither in the non-powered condition of the autorotative rotor nor in the fully powered condition of the propulsive rotor, but somewhere about half-way between these two extremes, it is appropriate that the control should conform to neither of the two conventional forms but should combine certain features of both. It resembles the tilting-hub method, but in the gyrodyne the hub axis, i.e., the axis of the main bearings, is not tilted. Instead, the rotor head (the hub member to which the blades are attached) is tilted with respect to the hub axis, and in forward flight the forward inclination of the head balances the backward inclination of the tip-path plane with respect to the head, so that the tip-path plane remains substantially at right-angles to the hub axis, giving effectively the same result as cyclic-pitch control.

The three flapping hinges all intersect on the axis of rotation and are inclined to the blade axes at about 60 deg. when operating at zero torque. In response to torque, this angle increases progressively and attains a value of about 70 deg at full torque. The automatic change in blade angle is associated with the angular displacement of the blade in azimuth, and is caused partly by a so-called "alpha one" inclination of the drag hinge and partly by the variation in "delta three." The combined effect is such that there is an immediate increase in boost whenever the throttle is opened, without there being any appreciable change in angular speed of the rotor. The blade articulations, therefore, self-govern the collective pitch quite independently of any over-riding collective-pitch control that may eventually be provided for other purposes.

Power Plant and Transmission System

The Fairey prototype is powered by an Alvis Leonides nine-cylinder air-cooled radial engine, which has a maximum sea-level rating of 515 b.h.p. at 3,000 r.p.m. It is mounted vertically inside the fuselage and cooled by a fan driven at engine speed. The cooling air is drawn in through openings in front of the rotor pylon and discharged through ducts in the tail unit. Ducts are also provided to deflect air through the oil cooler and the engine-driven generator.

The installation of the power plant and transmission consists of four self-contained units; first, the engine, its mounting and cooling system; second, the main gear box providing the first-stage reduction gears for the rotor and airscrew drives, and incorporating the clutch and the freewheel; third, the top gear box which houses a double epicyclic gear that provides the final gear reduction between the engine and the rotor, with a rotor brake mounted above it; and fourth, at the outer extremity of the starboard wing, a gear box carrying the airscrew reduction and pitch-changing gear.

The engine is coupled to the main gear box by a splined shaft carrying a multi-bush universal coupling at each end, the fan being mounted on the coupling nearer the engine. This arrangement allows the engine and fan to float on the rubber mountings provided for the engine, and covers mal-alignment between the engine and the main gear box.

Main Gear Box

The main gear box, which is mounted on four rubber bushes, carries the clutch, the vertical shaft drive, the side airscrew drive, the freewheel, the Lockheed pump drive, the oil pump for the main and top gear boxes, and the engine and rotor tachometer drives. The airscrew is positively geared to the engine and is unaffected by clutch operation. The vertical shaft is driven by bevel gears and the airscrew by a smaller pair of bevels. A central shaft running at engine speed carries the clutch casing, and the clutch plates are splined to an extension on the driving bevel. A Lucas actuator is provided for controlling the rate of clutch engagement, thus limiting the maximum starting torque and ensuring that the rotor blades cannot be broken by a sudden engagement of the clutch. The freewheel is located above the main bevel and, as the rotor tachometer and hydraulic pump are required to be driven when the rotor is freewheeling, the drives for these services are located above the freewheel.

Top Gear Box

The top gear box is coupled to the main gear box by a tubular vertical shaft fitted with a torsional rubber coupling